5.—Clastic Dykes From Watheroo, Western Australia

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At Watheroo a series of narrow clastic dykes has been injected into the Archaean granitic basement from the overlying Capalcarra Sandstone. The sediment forming the dykes, a first cycle orthoquartzite, has been derived from a weathered mantle overlying the crystalline rocks. The suggested mechanism of emplacement is by the slumping of unconsolidated sands into fissures in the granite which have opened under local tension stress associated with the instability in the basement rocks of the depositional area.

Introduction

Sedimentary (clastic) dykes intrude porphyritic microcline granite on an unconformity surface at Watheroo, a small town 140 miles north of Perth. The orthoquartzite forming these dykes is lithologically identical with the basal orthoquartzite unit of the Capalcarra Sandstone (Logan and Chase, 1956, ms.). This formation is the basal component of the Moora Group sediments which unconformably overlie the crystalline rocks on the periphery of the West Australian Precambrian shield in a sequence of approximately 4,000 ft. thickness.

The narrow northtrending belt of Moora Group outcrop which has been traced from its southern extremity at Moora as far north as Coorow was stratigraphically subdivided for the first time in 1956 by R. L. Chase and the author into four conformable formations of sandstone, siltstone, arkose and chert—the basal formation being the Capalcarra Sandstone to which the dykes are lithologically related. Proterozoic and Ordovician ages have been suggested for the Moora Group but the fossil evidence is uncertain so that both ages must be regarded as unsubstantiated.

Location and Description

The sandstone dykes are exposed in a small 1½ acre granite outcrop, 30 yards west of the Geraldton Highway, 3 miles north of Watheroo. The outcrop represents a slight upward undulation of the unconformity surface which has been stripped to form a granite inlier in the Capalcarra Sandstone surrounding it. The reader is referred to figure 1, a geological map of the sandstone dyke locality which shows the distribution of the dykes and a series of small shears which intersect them.

The clastic dykes, with the exception of one narrow north-north-west-trending dyke are subparallel and trend approximately E.-W. They commonly persist along their length for distances of 15 to 20 yards before thinning out or merging with a thin superficial soil which partially obscures the Capalcarra Sandstone outcrop. The width of the dykes varies from half an inch up to 8 inches; the average width is approximately 2 inches. The dykes are generally vertical but occasional steep dips of 80 to 85° N. and S. are recorded.

Although the dyke orthoquartzite is strongly cross-jointed the lack of cataclasis along the contacts indicates that the dykes have suffered little or no movement along their walls since lithification. They are, however, cut by N.N.E. and S.S.E. trending shears which have caused minor horizontal displacement (1 to 15 inches) of the dykes in some cases. Other dykes may

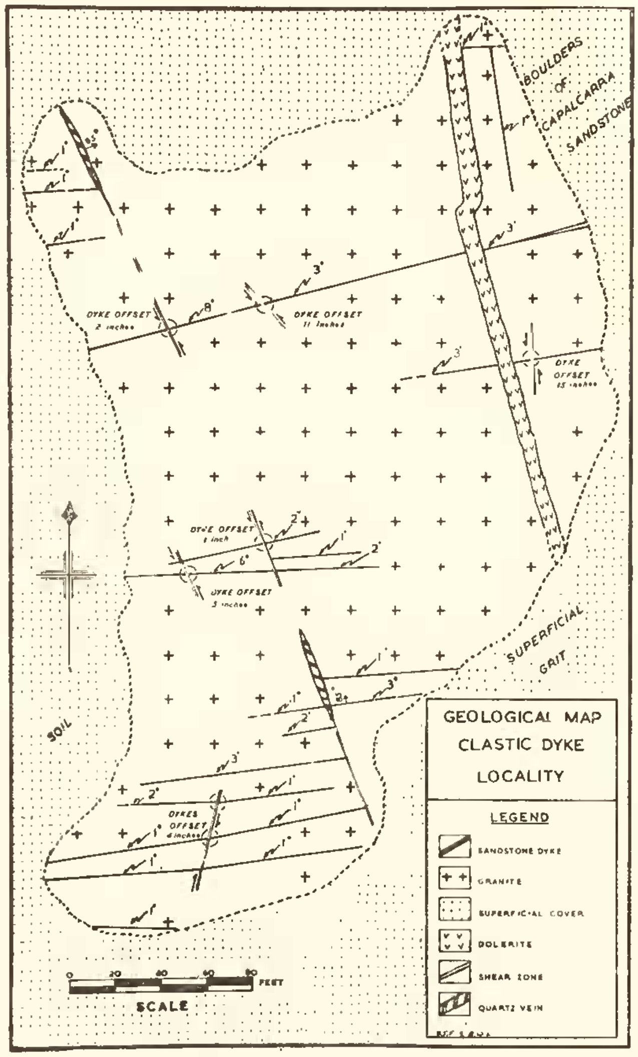

Fig. 1.—Geological map of clastic dyke outcrop at Watheroo.

cross the shear without apparent horizontal displacement. The movements may also have a small vertical component for there is often a difference in dyke width on opposite sides of the shear. The Watheroo area is a block-faulted terrain with a dominent west-block-down displacement but since no data are available on the behaviour of the sandstone dykes at depth generalisation as to the nature and extent of the movements that have effected the dykes is not possible.

A series of dolerite dykes intrude the Moora Group strata and a small dolerite dyke cuts across the sandstone dykes. The earlier shearing movements were accompanied by quartz emplacement in some of the shears.

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Petrography

The dyke material is a pink massive orthoquartzite of the first cycle with quartz making up more than 95% of the detrital fraction, 2% detrital microcline and an interstitial cement of authigenic sericite (Fig. 2). Secondary overgrowth of authigenic quartz on the detrital quartz grains has occurred but the original grain shape is well delineated by lines of minute, indeterminate inclusions. The grains were apparently well-rounded, and size sorting is poor; grain diameter ranges from 0.2 to 0.85 mm., the average grain diameter being approximately 0.5 mm.

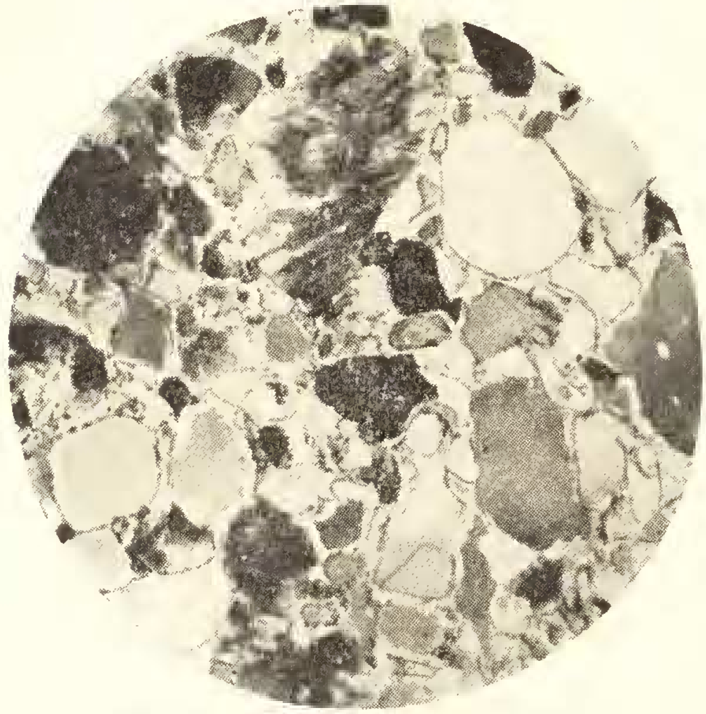

Fig. 2.—Photomicrograph, X 25. Orthoquartzite from a sandstone dyke at Watheroo. Note the secondary overgrowth of quartz on the detrital grains and the large detrital fragment of feldspar.

Three types of quartz grains are present: (a) quartz grains containing dark equant inclusions; (b) quartz grains with inclusions of acicular rutile; (c) quartz grains with internal suturing, denoting their derivation from vein quartz. All three features are consistent with the derivation of the grains from a metamorphic complex of granite and granitic gneiss. Microcline is present as tabular grains of 0.7 to 1.0 mm. average size. Sericite has been developed authigenically on both feldspar and quartz and the host granite has also suffered sericitisation.

Formation of the Dykes

Provenance

The orthoquartzite in the dykes is lithologieally identical with the basal unit of the Capalcarra Sandstone in the area. This formation with its variable thickness and wide lateral and vertical variation in lithology from poorly-sorted arkoses and arkosic conglomerates to orthoquartzites has the characteristics of a basal sand formed by the winnowing of a weathered rock mantle (regolith) under the strand line conditions which transgressed the granitic craton area. The quartzose detritus shows evidence of fairly extensive working in the high degree of rounding of the grains. Detrital feldspar on the other hand is similar in grain size to the microcline of the host granite and the angularity of the grains points to an *in situ* origin for this component. Nor is the poor sorting of the detritals consistent with prolonged transportation and it seems that wave action is the most likely agent of deposition.

Mechanism of Injection

The small S.S.E. and N.N.E. shears are especially significant in considering the emplacement mechanism of the dykes. The dykes and shears are probably co-genetic and contemporaneous, formed by *local* tensional stress, directed normal to the trend of the dykes, i.e. N.-S. tensional stress, which was relieved by opening of the dyke fissures and by smaller auxilliary movement along the shear directions. The fissures once opened were immediately filled by slumping into them of mobile water-saturated Capalcarra sands which were overlying the moving basement. In one case a small dyke was emplaced in the S.S.E. trending shear direction.

Vintage (1954) considered that sandstone dykes intruding granites in Colorado formed by injection of clastic material from above along submarine faults, i.e. these dykes were formed after the granite and gneiss had been covered by sediments and before the lithification of the latter. The dykes in Colorado are, however, much larger and more extensive than the Watheroo dykes and they have pronounced cataclasis at their edges; they are emplaced in fault zones. The Watheroo dykes are much smaller and have not suffered later movements along their edges. However, the massive unstratified and homogeneous nature of the orthoquartzite indicates a slump origin for these also, rather than emplacement by slow washing in of clastic material into open joints on a pre-Capalcarra surface, a process which would produce stratification in the dykes. Fairbridge (1946) points out that sandstone dykes are commonly associated with slumping and are related to movement contemporaneous with sedimentation. Certainly the dykes occur in a zone of instability, being adjacent to the Darling Fault and within the shatter zone of this major rift. Such an instability in the depositional area is not only indicated by the sandstone dykes, but is mirrored in the lower formations of the Moora Group where arkose and tuffaceous siltstones predominate.

Acknowledgements

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